FISHERY RESOURCES IN THE KISARALIK RIVER BASIN, YUKON DELTA NATIONAL WILDLIFE REFUGE, ALASKA, 1986

Dave Faurot
and
Ray N. Jones

Kenai Fishery Assistance Office
U.S. Fish and Wildlife Service
P.O. Box 1670
Kenai, Alaska 99611

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ABSTRACT

From June 9 to September 13, 1986, fishery resources of the Kisaralik River drainage basin were surveyed to: 1) determine species composition, relative abundance, and distribution of fish populations, 2) collect age, weight, and length data from specific fish species, 3) describe public boating and sport fishing use, and 4) identify and evaluate current and potential aquatic resource problems.

Ten of the fifteen species collected were salmonids and included six species of Pacific salmon: coho salmon *Oncorhynchus kisutch* (*N*=276), chinook salmon *O. tshawytscha* (*N*=98), chum salmon *O. keta* (*N*=33), rainbow trout *O. mykiss* (*N*=14), sockeye salmon *O. nerka* (*N*=13), and pink salmon *O. gorbuscha* (*N*=3). Other salmonids included 88 Dolly Varden *Salvelinus malma*, 39 Arctic grayling *Thymallus arcticus*, 38 round whitefish *Prosopium cylindraceum* and 11 lake trout *S. namaycush*. Non-salmonids included 50 slimy sculpin *Cottus cognatus*, 20 northern pike *Esox lucius*, 14 ninespine stickleback *Pungitius pungitius*, 4 longnose sucker *Catostomus catostomus*, and 2 Alaska blackfish *Dallia pectoralis*.

Range extensions of chinook, chum, coho and sockeye salmon were observed within the drainage and submitted to the Alaska Department of Fish and Game for inclusion into the Anadromous Stream Catalog.

Dolly Varden and Arctic grayling were the most abundant and widespread resident sport fish. Rainbow trout were less abundant and more restricted in range. Chinook and coho salmon were observed or captured throughout the drainage, whereas pink salmon were only captured in one of five river sections sampled.

Sport fishing effort and public use of the river was light with only 79 people observed during 15 surveys conducted by aircraft, river raft and jet boat trips. Only 19 (24%) of the people observed were sport fishing. An estimated 69 angler days of use occurred on the Kisaralik River in 1986, but this is considered a minimum estimate since an unknown number of anglers were not contacted during our surveys. Based on angler interviews, coho salmon were the most frequently captured species, followed by Arctic grayling, Dolly Varden, and rainbow trout.

Salmon populations appear to be depressed with less than 50 chinook and 200 adult chum salmon observed and only three adult pink salmon collected. Aerial surveys conducted by the Alaska Department of Fish and Game indicated that escapement was consistently below established goals during 16 surveys for chinook salmon and 17 surveys for chum salmon between 1960 and 1985. Aerial surveys are not conducted for pink, sockeye or coho salmon.

Commercial fishing is not allowed in the Kisaralik River, but in 1986, commercial and subsistence harvests in the lower Kuskokwim River were approximately 61,000 chinook and 400,000 chum salmon. To minimize harvests of depressed stocks such as Kisaralik River chinook and chum salmon, a multi-year study would be required to determine the abundance and run timing of the various stocks within the drainage.

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INTRODUCTION

The Kisaralik River system, including Kisaralik Lake, is an important contributor to the subsistence, commercial, and sport fisheries of Bethel and nearby villages. Commercial, subsistence, and sport anglers, as well as fisheries managers, have concerns about declining salmon populations in the Kuskokwim River drainage. Chinook salmon *Oncorhynchus tshawytscha*, traditionally the most important species, are the main concern, followed by the more numerous chum salmon *O. keta*.

Commercial fishing is not permitted in the Kisaralik River. However, commercial salmon fishing in the Kuskokwim River intercepts salmon returning to the Kisaralik River and other tributaries. Because of declining populations, Kuskokwim River commercial fisheries were restricted to 15 cm or smaller stretched mesh gill nets in 1985 to reduce the harvest of larger female chinook salmon. In 1987, the Alaska Board of Fisheries approved regulations to eliminate directed commercial harvest of chinook salmon in order to provide for sustained subsistence harvest and spawning escapement (Alaska Department of Fish and Game 1989). Subsistence anglers target chum and chinook salmon in the lower Kisaralik River and in the Kuskokwim River within 50 m of the Kisaralik River mouth.

The Kisaralik River is also one of the most popular sport fishing rivers on the Yukon Delta National Wildlife Refuge (Ron Perry, U.S. Fish and Wildlife Service, personal communication). Sport fishing for salmon, Dolly Varden *Salvelinus malma*, and Arctic grayling *Thymallus arcticus* occurs throughout the river. Rainbow trout *O. mykiss* fishing occurs primarily from the Upper Falls downstream to the braided area of the river.

In the last 20 years, the Kisaralik River has been considered for industrial development (hydroelectric dam site), preservation (nominated for "Wild and Scenic River" status), and increased recreational use (sport fishing outfitters and guides requesting Special Use Permits). Surveys have been conducted for biological, developmental, and conservation reasons (U.S. Department of Interior 1976; Heritage Conservation and Recreation Service 1979; U.S. Department of Interior 1984; Baxter 1981, 1982; Alt 1978; Boyce and Fristensky 1984). However, the most recent information is seven years old and may not reflect current conditions.

The goal of this study was to provide managers with information regarding the fisheries resources of the river. The objectives were to:

1. Determine species composition, relative abundance and distribution of fish populations;

2. Collect age, weight, and length data from specific fish species;

3. Describe public boating and sport fishing use; and,

4. Identify and evaluate current and potential aquatic resource problems.

STUDY AREA

The Kisaralik River originates approximately 140 km southeast of Bethel, Alaska, in the Kuskokwim Mountains and flows northwest 176 river kilometers (rkm) where it empties into the Kuskokwim River 64 rkm upstream from Bethel (Figure 1). The Kisaralik River drains about 2,850 km^2 and is non-glacial, flowing out of snow-fed Kisaralik Lake (U.S. Department of Interior 1976, 1984). Water clarity is directly related to riverbed materials. The river is clear in the rocky upper reaches and brown and turbid in the lower reaches. Tributaries are small and clear (U.S. Department of Interior 1984).

The river was divided into five (I-V) major sections (Figure 1). Section I extends from the headwaters at Kisaralik Lake downstream to Upper Falls (rkm 138) and includes Gold and North Fork lakes. These deep, clear lakes are bordered by mountains that remain snow capped throughout the summer. Many glacial cirque basins and morainal deposits are visible from the lakes. Dense stands of willow and alder are the dominant riparian vegetation adjoining the river. In this section, the river is shallow, swift, clear, and 10-30 m wide. It is characterized by few pools, clean gravel, cobble, and boulder substrate, and some braided channels. Quicksilver Creek is the major tributary in the lower reach of this section. The lower 5 km of this section is within the Yukon Delta National Wildlife Refuge (refuge).

Section II extends from Upper Falls (rkm 138) to Golden Gate Falls (rkm 112) and is wider than Section I. This section is relatively shallow, swift, and has gravel, cobble, and boulder substrates. There is little braiding in this section and pools are rare. The river passes through a canyon with pinnacles, columns, and bluffs as it flows through the Kilbuck Mountains which rise 650-2,000 m above the valley floor. Cottonwood, white spruce, and black spruce begin to appear in the lower reaches. Swift Creek is the primary tributary in this section (Figure 1), which is entirely within the refuge.

Section III extends from Golden Gate Falls (rkm 112) to approximately rkm 68. This section is clear, unbraided, and deep enough for outboard motor boats, but strewn with larger boulders. Power boats cannot negotiate Golden Gate Falls. The landscape is dominated by birch, aspen, cottonwood, and white spruce in the floodplain. Quartz, Clear, and Nukluk creeks are the primary tributaries (Figure 1). There is a primitive landing strip for small aircraft at Kelly's Camp (rkm 90). The lower portion of Section III is Native owned; the upper part is a combination of Native and refuge ownership.

Section IV (approximately rkm 36-68) is locally referred to as "the braids" and is more turbid than upstream sections. This section is 50 to 100 m wide, swift, shallow, with divided channels, and is

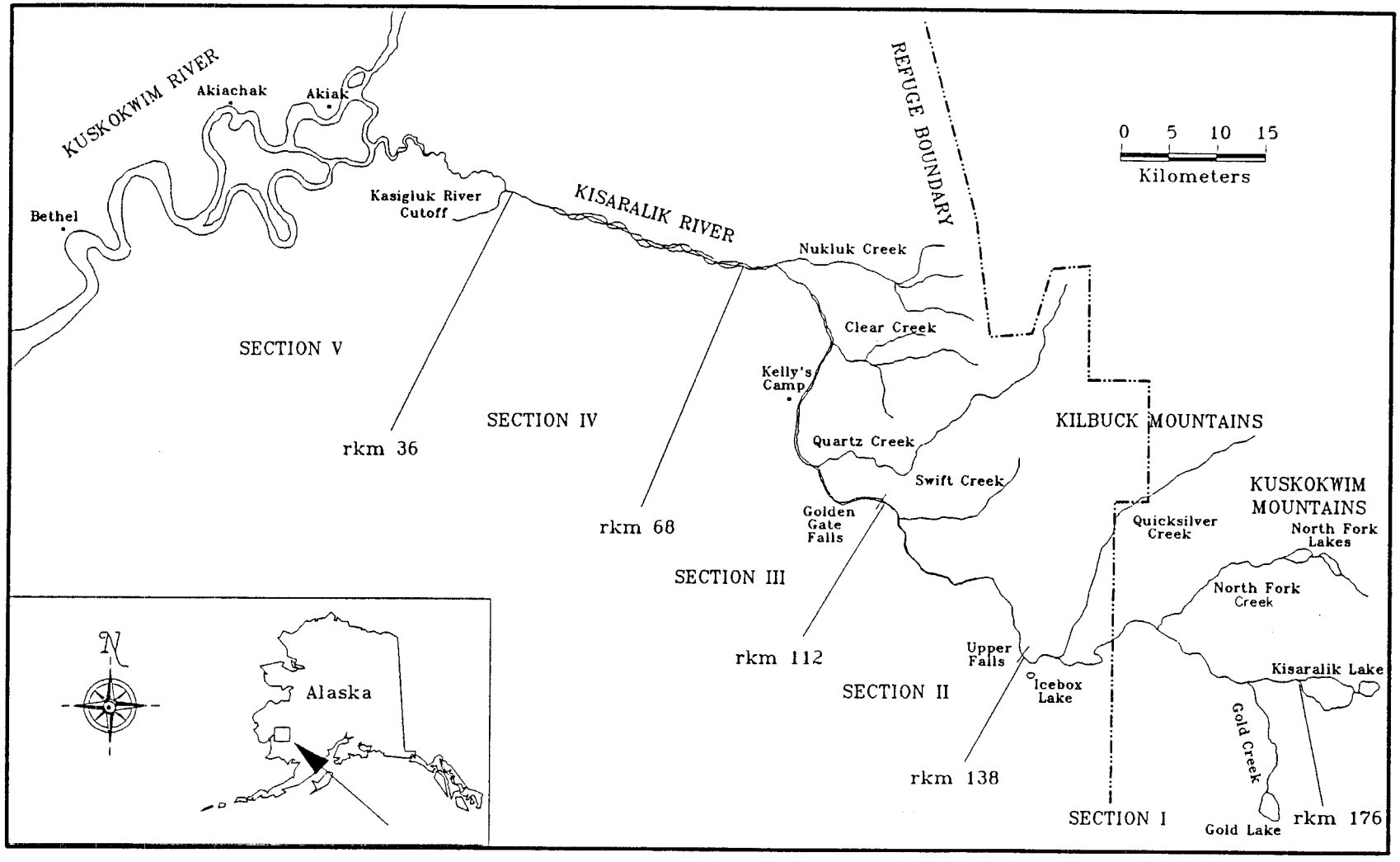

FIGURE 1. --Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska.

characterized by quick turns, gravel bars, windfallen trees, and sweepers. Jet boats can usually negotiate this area of the river. The physical appearance of this section changes dramatically with changes in water level. There are no major tributaries. Willow mixed with spruce is the dominant riparian vegetation in the upper reaches while birch is dominant downstream. Land along the river is Native owned.

Section V is poorly drained and has continuous permafrost except in the floodplain where the banks are unstable and frequently slough into the stream (U.S. Department of Interior 1976). It is easily negotiated by outboard motor boats and has turbid water, slow current, and extensive riparian vegetation dominated by willow and alder. The Kasigluk River cutoff enters just below rkm 36. The land is Native owned.

METHODS

Data collection was concentrated in Sections I-IV, especially Sections III and IV where most of the public use occurs (Ron Perry, U.S. Fish and Wildlife Service, personal communication). The lower 68 rkm were accessed from Bethel by jet boat. Kisaralik and Gold lakes were accessed by float-equipped aircraft where rafts were launched to access areas downstream. Lower sections of tributaries were reached by hiking. Sampling trips were scheduled to coincide with the timing of adult salmon returns and took place June 9-19, July 14-27, August 13-25, and September 5-13, 1986.

Relative Abundance and Distribution

Sampling was conducted throughout the river at locations that appeared to be productive as time, logistics, and weather permitted. Sampling was opportunistic, covering a variety of habitats, and used the gear type that best sampled the habitat. Fish were collected using spin fishing gear, set gill nets, drift gill nets, beach seines, dip nets, and minnow traps (Table 1). Species that were visually observed in a section but not collected were counted when possible or recorded as "present but not sampled." To reduce sampling mortality, angling and drift gill nets were primarily used to sample adults and minnow traps baited with salmon eggs were used to collect juveniles.

Age, Weight, and Length

Juvenile and resident fish were measured to the nearest mm (fork length) and resident fish were weighed to the nearest 5 g. Adult salmon were measured to the nearest 5 mm (mid-eye to fork length) and weighed to the nearest 25 g. Sex of adult salmon was determined from external characteristics. Ovaries from Dolly Varden and lake trout were visually examined for maturity stage.

Scale samples were taken from rainbow trout, lake trout, and adult salmon in the vicinity of the third scale row above the lateral line and

TABLE 1.—Sampling gear used in the Kisaralik River watershed, Yukon Delta National Wildlife Refuge, Alaska, 1986.

Gear type	Length (m)	Depth (m)	Mesh	Section/habitat sampled
Gill net, floating, experimental mesh	15.2	3.0	Five panels, 1.0, 1.3, 1.6,1.9, 2.5 cm stretch mesh	lakes
Gill net, floating	18.3	3.7	14 cm stretch mesh	III, IV, V
Gill net, floating experimental, monofilament	12.2	1.8	Four 3.0 m panels, 9, 14, 15, 18 cm stretch mesh	I, II, III, V
Beach seine	12.2	1.8	6 mm mesh	lakes, I, II, III, IV, V
Dip net			6 mm mesh	I, II, lakes, tributaries
Minnow traps	0.4	0.2	3 mm mesh	I, II, III, IV, V, lakes, tributaries
Spin fishing gear				I, II, III, IV, lakes

on the diagonal from the anterior insertion of the anal fin to the posterior insertion of the dorsal fin. Impressions of adult scales were made on cellulose acetate cards and examined with a microfiche reader. Salmon ages are reported using the European Method (Koo 1962).

Public Boating and Sport Fishing Use

Public use was determined by conducting aerial surveys over the entire river, jet boat surveys while running to and from lower river sampling areas, and float surveys from the lakes downstream. The number of people seen on the river and their activities were recorded and used to calculate the percentage of people engaged in each activity.

Anglers encountered on the river were interviewed to determine the species and number of fish caught, harvested, or released, and the amount of fishing effort. Fishing effort for the entire season was determined by expanding the mean number of anglers per day by the total possible fishing time in the season (Neuhold and Lu 1957). Catch rates were calculated by dividing the total number of fish caught, harvested, and released by the number of hours fished.

Aquatic Resource Problems

Prior to the resource inventory, several aquatic resource problems were identified by local residents and refuge personnel. Reports of depressed salmon populations were evaluated by comparing inventory results with aerial survey index counts and visually observing the Upper Falls area to determine if it was a barrier to salmon migrating upstream. Reported excessive turbidity in Quicksilver Creek was evaluated by taking Secchi disk readings in the creek and adjacent river areas. Potential overharvest of rainbow trout was evaluated using age data and harvest rates.

RESULTS AND DISCUSSION

Relative Abundance and Distribution

A total of 15 species was collected in the Kisaralik River (Table 2) including 10 species of salmonids. All species collected during this survey had been previously documented in the Kisaralik River (Alt 1978; Baxter 1982). However, Baxter (1982) collected eight species not observed during this survey. Failure to collect those species was probably due to limited sampling efforts rather than the absence of those species.

Both Alt (1978) and Baxter (1982) reported collecting Arctic char *S. alpinus* and neither reported collecting Dolly Varden. The two species are very similar and difficult to distinguish without meristic counts. Therefore, all the specimens collected in this survey were reported as Dolly Varden. Dolly Varden collected in headwater lakes and at Upper Falls displayed considerable differences in coloration from Dolly Varden

TABLE 2.—Scientific and common names of the fish species found in the Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska.

Scientific name	Common name
Lampetra japonica[a]	Arctic lamprey
Coregonus nasus[a]	broad whitefish
Coregonus pidschian[a]	humpback whitefish
Coregonus sardinella[a]	least cisco
Oncorhynchus gorbuscha	pink salmon
Oncorhynchus keta	chum salmon
Oncorhynchus kisutch	coho salmon
Oncorhynchus mykiss	rainbow trout
Oncorhynchus nerka	sockeye salmon
Oncorhynchus tshawytscha	chinook salmon
Prosopium cylindraceum	round whitefish
Salvelinus alpinus[a]	Arctic char
Salvelinus malma	Dolly Varden
Salvelinus namaycush	lake trout
Stenodus leucichyhys[a]	sheefish
Thymallus arcticus	Arctic grayling
Hypomesus olidus[a]	pond smelt
Dallia pectoralis	Alaska blackfish
Esox lucius	northern pike
Catostomus catostomus	longnose sucker
Lota lota[a]	burbot
Pungitius pungitius	ninespine stickleback
Cottus cognatus	slimy sculpin

[a] Species not found in this study, but documented by Baxter (1982).

collected elsewhere in the Kisaralik River. The differences in coloration could be due to several possible situations: the presence of both resident and anadromous forms of Dolly Varden, the presence of both Dolly Varden and Arctic char, or differences in sexual maturity. Neither Alt (1978) nor Baxter (1982) reported observing coloration differences in Arctic char.

Resident fish—Dolly Varden (*N*=88), slimy sculpin (*N*=50), Arctic grayling (*N*=39) and round whitefish (*N*=38) were the most abundant resident species captured. Northern pike, rainbow trout, lake trout, ninespine stickleback, longnose sucker, and Alaska blackfish were also captured but numbered 20 or less. Dolly Varden were the most widely distributed resident species and were collected in every major study section (Table 3) including the headwater lakes. Rainbow trout were collected only in river sections III and IV although Section II appeared to provide good rainbow trout habitat. Section V did not appear to offer good rainbow trout habitat but may be an adult overwintering area or juvenile rearing area. Lake trout were collected only in the headwater lakes. Northern pike, round whitefish, longnose sucker, ninespine stickleback, and Alaska blackfish were collected only in Section V.

Arctic grayling were collected in sections III, IV, and V. Previous surveys by Alt (1978) and Baxter (1982) documented Arctic grayling in Kisaralik Lake (Section I) and Baxter (1982) collected them in the river above Golden Gate Falls (Section II). Baxter (1982) also collected round whitefish in Kisaralik and North Fork lakes as well as in the river above Golden Gate Falls. Failure to collect Arctic grayling and round whitefish in these areas during this survey was probably due to limited sampling effort.

Salmon—Five species of salmon were captured with coho (*N*=276) and chinook salmon (*N*=98) predominant in our catches. Salmon were widely distributed throughout the Kisaralik River except for pink salmon, which were only observed in Section IV (Table 3). Chinook and coho salmon were observed throughout the river including Section I (Table 3). Sockeye were observed spawning in Section IV and in Gold Creek (Section I). Sockeye salmon fry were only collected in Section V (Table 3). Chum salmon were observed from Section V upstream into Section II above Golden Gate Falls; none were observed at or above Upper Falls. Most chum salmon were observed in the slower side channels of the braids where partially eaten carcasses were observed along the banks.

Chinook salmon were first observed in the river in early July. High and turbid water hampered efforts to determine spawning times and sites, but ripe adults were sampled before, and carcasses were sampled after the normal July 15 to August 10 spawning period (D. Schneiderhan, Alaska Department of Fish and Game, personal communication). A few chum salmon were found spawning as early as July 18 while others had not spawned by August 16. Coho salmon were first observed in the river in early August. Coho salmon observed as late as September 13 had not commenced

TABLE 3.—Occurrence of adult (A) and juvenile (J) fishes sampled in five study areas of the Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska, 1986 (P = present but not sampled, C = carcasses observed).

	River section									
	V		IV		III		II		I	
Species	A	J	A	J	A	J	A	J	A	J
Chinook salmon	1	7	P	45	6	39	C		C	
Chum salmon	4	9	20		P		P			
Coho salmon		118	42	65	6	30	11		4	P
Sockeye salmon		8	3		P				2	
Pink salmon			3							
Rainbow trout			10		4					
Dolly Varden		2	6	34	7	8	13	P	6	12
Arctic grayling	2		7		30					
Lake trout									11	
Northern pike	20									
Round whitefish	9	29								
Longnose sucker		4								
Slimy sculpin	34				5				11	
Ninespine stickleback	14									
Alaska blackfish		2								

spawning, indicating that the spawning period for this species probably extends into late September or early October. Very few sockeye salmon were observed during our surveys and only five adults were collected (Table 3). The earliest observation of sockeye salmon was in mid-August and two additional sockeye salmon were seen in late August. Sockeye salmon are not common in the Kisaralik River and were not reported in the system before 1981 (Baxter 1981).

Only three pink salmon were observed, which occurred on August 14-15. Alt (1978) and Kavanaugh (U.S. Department of Interior 1976) reported seeing pink salmon running in even years. Baxter (1981) estimated seeing more than 10,000 chum and pink salmon spawning in the area between Golden Gate Falls and the mouth in 1980. Baxter did not state the proportion of each species in his estimate but, unless pink salmon were a very small percentage, it appears that the pink salmon population in the Kisaralik River has declined.

Several range extensions of salmon in the Kisaralik River were documented during the survey and nominated for inclusion in the Alaska Department of Fish and Game Anadromous Stream Catalog (Table 4). The extensions are chinook, coho, sockeye, and chum salmon rearing and migration habitats in Gold and Quartz creeks and downstream of the outlets of North Fork and Kisaralik lakes.

TABLE 4.—Range extensions of salmon nominated to the Alaska Department of Fish and Game Anadromous Stream Catalog, Kisaralik River drainage, Alaska, 1986.

Species	Date	Rearing	Migration	Location
Chinook salmon	7/17/86	X		Lower 100 m of Quartz Creek
Chinook salmon	7/17/86		X	Lower 2 km of Quartz Creek
Chum salmon	7/17/86		X	Lower 2 km of Quartz Creek
Coho salmon	9/6/86		X	2 km below outlet of Kisaralik Lake
Coho salmon	8/19/86	X		Outlet of Upper North Fork Lake
Coho salmon	7/17/86	X		Lower 100 m of Quartz Creek
Coho salmon	9/8/86		X	Lower 2 km of Quartz Creek
Sockeye salmon	8/20/86		X	Gold Creek, 5 km below Gold Lake

Age, Weight, and Length

Resident fish—Of the five resident sport fish species captured during the survey, the only juvenile fish captured were Dolly Varden. Juvenile Dolly Varden (*N*=56) ranged in length from 32-146 mm (mean=62, SD=28). The range and mean lengths and weights of adult resident fish are presented in Table 5. Ages were not determined for Dolly Varden. Adult Dolly Varden collected in the headwater lakes and at Upper Falls had two distinct sizes of reproductive organs suggesting non-consecutive year spawning (*N*=6).

The smallest rainbow trout was 325 mm long and 5 years old. Age groups 5, 6, 7, 8, 9, and 11 were represented (*N*=12). Two larger rainbow trout, 580 and 490 mm, were caught by anglers but were not included in Table 5 because of evisceration. No juvenile rainbow trout were collected. This is consistent with Alt's (1977) inventory in which no young-of-the-year and only 5 rainbow trout in the 96-180 mm range were captured. A three year investigation of the Kanektok River rainbow trout (1985-1987) captured no young-of-the-year and a total of one age 1 fish, four age 2 fish, and 38 age 3 fish (Wagner 1991).

Some of the rainbow trout sampled had red slashes typical of cutthroat trout *O. clarkii* on the underside of the jaw. Alt (1978) found this in Aniak River rainbow trout and Scott and Crossman (1973) indicated it sometimes occurs in rainbow trout. The Kisaralik River is not within the range of anadromous rainbow trout (Morrow 1980).

Ages of lake trout ranged from 4 to 8 years (*N*=9). Two sizes of eggs suggested non-consecutive year spawning (*N*=4). No juvenile lake trout were caught in minnow traps or fine mesh gill nets.

TABLE 5.—Mean lengths and weights of adult resident fish in the Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska, 1986.

		Length (mm)			Weight (g)		
Species	N	Mean	SD	Range	Mean	SD	Range
Dolly Varden	32	436	89	370-555	775	426	420-2,075
Rainbow trout	12	428	49	325-480	838	275	340-1,200
Lake trout	11	506	30	470-560	1,346	286	940-1,850
Northern pike	20	405	90	225-570	498	309	60-1,200
Arctic grayling	33	330	49	230-430	357	156	120-740

Salmon—Sex ratios ranged from 63 to 86% male for the five salmon species (Table 6). All chinook and sockeye salmon had one freshwater annulus and most coho salmon had two. Pink and chum salmon, which migrate to sea upon emergence from the gravel, showed none. All coho and pink salmon spent one winter at sea, while chum salmon spent three or four. Chinook salmon showed the most variability in marine residence time, ranging from two to five years.

Public Boating and Sport Fishing Use

Fifteen surveys were conducted: four aerial, three float and eight by jet boat. A total of 79 people were counted on the river associated with 5 rafts, 21 boats, and 2 airplanes. The surveys indicated that 24% were sport fishing, 20% rafting, 16% berry picking, 42% camping, 14% subsistence fishing, and 42% engaged in unknown activities (Table 7). Several people were involved in one or more activities (e.g. sport fishing and rafting) which caused the percentages to total more than 100%. Other activities such as photography, bird watching, wildlife viewing, etc., were not documented.

An average of 5.3 persons were seen per survey. By comparison, Lisac and Minard (1984) recorded an average of 24 anglers per survey on the Goodnews River in 1984, and during the summer of 1985, Martin (1985) recorded 37 persons per day floating the Kanektok River from Kagati Lake. The Goodnews and Kanektok rivers have commercial sport fishing guides operating on the rivers which accounted for much of the additional pressure. Issuance of Special Use Permits to allow outfitters or guides to operate on the Kisaralik River could cause an increase in public use.

Sport fishing pressure on the Kisaralik River was less than that experienced on popular western Alaska rivers and a specific effort had to be made to locate anglers. An estimated 69 angler days (defined as any day in which any part was spent fishing) of use occurred on the Kisaralik River in 1986 (Table 8). The estimated 69 angler days is a minimum estimate of angler use since an unknown number of anglers were not encountered during our surveys. Use on other western Alaska rivers ranged from 1,517 to 6,881 angler days (Table 9). Of the anglers contacted on the Togiak River, 71% were with guides (Lisac and Minard 1984).

Based on interviews, coho salmon were the most frequently caught fish, followed by Arctic grayling, Dolly Varden, and rainbow trout (Table 10). Only 2.6% of the fish caught were harvested, and rainbow trout were kept at the highest rate (5.3%). July and August were the months where fishing pressure was the highest. Dolly Varden were available to the angler over a greater area than other species. During their spawning migration, coho salmon were the most visible fish species and generated the most excitement. Areas of heaviest use were the pool below Upper Falls, the mouth of Quartz Creek, Kelly's Camp, and backwaters and side channels in the braids.

TABLE 6.—Mean length and weight by age and sex of adult salmon in the Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska, 1986.

				Length (mm)			Weight (kg)		
Species	Sex	Age	N	Mean	SD	Range	Mean	SD	Range
Chinook salmon	Male	1.2	2	508	-	490-525	2.01	-	1.50-2.53
		1.3	3	685	-	640-750	4.88	-	3.65-6.65
		1.4	1		-	830		-	10.60
	Female	1.5	1		-	965		-	10.30
Sockeye salmon	Male	1.3	2	585	-	560-610	4.08	-	3.65-4.50
	Female	1.3	1		-	510		-	1.65
Chum salmon	Male	0.3	4	578	-	510-600	3.14	-	2.25-3.95
		0.4	10	628	23	590-660	3.75	0.57	2.90-4.90
	Female	0.3	2	565	-	560-570	2.60	-	2.35-2.85
		0.4	6	568	30	510-600	2.32	0.30	1.70-2.65
Coho salmon	Male	1.1	3	543	-	510-570	2.32	-	2.00-2.65
		2.1	22	568	34	470-610	2.97	0.48	1.60-3.80
	Female	1.1	1		-	520		-	1.90
		2.1	14	545	35	480-605	2.47	0.47	1.70-3.70
Pink salmon	Male	0.1	2	450	-	440-460	1.45	-	1.20-1.70
	Female	0.1	1		-	400		-	0.90

TABLE 7.—Activities of persons observed during aerial, float and jet boat surveys, Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska, 1986.

Date	Number of persons[a]	Activity					
		Sport fishing	Berry picking	Rafting	Camping	Subsistence fishing	Unknown/ other
6/10[b]	0						
6/14	3	3					
6/15	0						
6/16	2	0					2
6/17	6	0				6	
7/13[b]	4	0					4
	5	2			5		3
	4	1			4		3
	2	1					1
	3	0					3
	2	0		2			2
	4	2			4		2
7/15	3	0					3
	2	0					2
	2	0					2
7/16	4	2			4		2
7/19	1	0			1		
7/20-23[c]	0						
7/24[c]	2	0		2			2
7/25[c]	13	0	13		13		
7/30[b]	2	0		2	2		
	5	0				5	
8/13	0						
8/16[d]	0						
8/18-20[c]	0						
8/21[b,c]	4	2		4			2
8/22[c]	0						
8/23[c]	6	6		6			
8/24[c]	0						
9/5-10[c]	0						
Total	79	19 (24%)	13 (16%)	16 (20%)	33 (42%)	11 (14%)	33 (42%)

[a] The total number of persons does not equal the sum of people by activities as some people were involved in more than one activity (i.e. rafting and fishing).
[b] Aerial survey.
[c] Float survey.
[d] Boats present, but no people observed.

TABLE 8. —Estimated sport fishing effort on the Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska, June-September, 1986; from aerial, float and jet boat surveys.

Month	Number days sampled	Number observed					Mean number anglers per day	Estimated monthly effort (angler days)[a]
		Plane	Raft	Boat	People	Anglers		
June	5	0	0	3	11	3	0.6	18.0
July	11	2	2	16	58	8	0.7	22.6
August	9	0	3	2	10	8	0.9	27.9
September	5	0	0	0	0	0	0.0	0.0
Total	30	2	5	21	79	19	0.6	68.5

[a] Mean number of anglers x days/month.

TABLE 9.—Angling pressure on various western Alaska streams.

River	Year	Angler days	Reference
Kisaralik	1986	69	This study
Togiak	1984	2,800[a]	Lisac and Minard 1984
Goodnews	1985	4,214	Mills 1986
Kanektok	1983	1,517	Mills 1984
Kanektok	1984	6,881	Mills 1985
Kanektok	1985	4,630	Mills 1986
Kanektok	1986	3,319	Minard 1987 Wagner 1991

[a] Guided anglers accounted for 71% of this total.

A large percentage of the anglers came to fish for rainbow trout. Information from angler interviews indicated the rainbow trout catch observed during this study was low in comparison to angler expectation. According to those interviewed, the limited access to the Kisaralik River enhanced the wilderness experience. Kisaralik, Gold, and Icebox lakes provided the only reasonable float trip access to the river during the three to four ice-free months. The airstrip at Kelly's Camp is primitive and best suited for small airplanes. The easiest access was by boat from the Kuskokwim River. Boats were limited by the type of propulsion, water level, and Golden Gate Falls.

Aquatic Resource Problems

Depressed salmon populations—Commercial, subsistence, and sport anglers, as well as fisheries managers, have concerns about declining salmon populations in the Kuskokwim River drainage. Chinook salmon, traditionally the most important species, are the main concern, followed by the more numerous chum salmon. On the refuge, the Kisaralik River is one of only five salmon spawning tributaries. The Alaska Department of Fish and Game (Department), Commercial Fisheries Division, has conducted aerial surveys of the Kisaralik River since the 1960's but, because of variable counting conditions, has never determined a population estimate or established an escapement goal for each species. Instead, the Department set an aerial survey index objective. Currently the index objective from Kisaralik Lake to rkm 68 is 1,000 chinook salmon and 8,000 chum salmon; no objectives have been set for coho, pink, or sockeye salmon (Alaska Department of Fish and Game 1985). The

TABLE 10. —Numbers of fishes caught/harvested by anglers interviewed on the Kisaralik River, Yukon Delta National Wildlife Refuge, Alaska, June-September, 1986.

Month	Angler days represented by interviews	Species								
		Chinook salmon	Sockeye salmon	Chum salmon	Lake trout	Coho salmon	Rainbow trout	Dolly Varden	Arctic Grayling	Total
June	2	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
July	2	0/0	0/0	0/0	0/0	0/0	0/2	1/0	0/4	1/6
August	25	0/0	0/0	0/0	0/0	120/3	38/0	86/0	102/0	346/3
September	0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Total (%kept)	29	0/0	0/0	0/0	0/0	120/3 (2.5%)	38/2 (5.3%)	87/0 (0%)	102/4 (3.9%)	347/9 (2.6%)

Department has not conducted aerial survey counts of coho salmon in the Kisaralik River in the past but has assumed a desired coho salmon index objective of 8,000 fish.

Between 1960 and 1985, sixteen aerial survey index counts of Kisaralik River chinook salmon ranged from 38 (1979) to 2,417 (1978) and averaged 511 fish. Seventeen chum salmon index counts were completed during the same period with a range of 20 (1965) to 10,921 (1976) and a mean of 3,595 fish (Schneiderhan 1983, 1988). During this 26 year period the chinook salmon index objective was only exceeded in 1960 and 1978 and index counts of 500 or more occurred in 1970, 1976 and 1981. The chum salmon index objectives were exceeded in 1966, 1975 and 1976 and index counts of 4,000 or more occurred in 1960, 1968, 1970 and 1981.

Aerial survey index counts were not conducted on the Kisaralik River in 1986 because of poor weather conditions. The only data available on 1986 salmon escapements into the Kisaralik river were observations made during this survey. Only seven chinook salmon were actually collected but approximately 10 were observed at the mouth of Quartz Creek on July 16 and 10-15 chinook salmon were observed in the plunge pool below Upper Falls on July 22. Although no record was kept, several chinook carcasses were observed in sections I and II. Altogether, less than 50 chinook salmon were seen during the survey. Based on these data, chinook salmon escapement into the Kisaralik River in 1986 was probably very similar to escapements in 1984 and 1985. Conclusions are similar for chum salmon as well. Only 24 were actually collected and the total number of spawning adults and carcasses seen during the survey was less than 200. Sport fishing data also support these conclusions. No chinook or chum salmon were reported caught by sport anglers interviewed (Table 10).

Although commercial fishing is not allowed in the Kisaralik River, there was an intensive commercial fishery in the mainstem Kuskokwim River targeting both chinook and chum salmon prior to 1987. In addition, subsistence fishing for salmon in the Kuskokwim is also quite intensive. The total numbers of chinook and chum salmon harvested in the lower Kuskokwim River commercial and subsistence fisheries (Commercial Fishing District 1) are listed in Table 11.

Upper Falls was thought to be a barrier to salmon migrating upstream, thus preventing the full use of the upper watershed, especially the lakes for sockeye salmon spawning and rearing. Upper Falls is not a complete barrier to upstream migration since fish were observed successfully jumping the falls during this survey and by Baxter (1981). In addition, adult chinook, coho, and sockeye salmon were observed above the falls. During low flows, however, concentrations of fish were seen below the falls, and the falls may become a barrier to migrating fish during these periods.

TABLE 11.—Numbers of chinook and chum salmon harvested in the commercial and subsistence fisheries in the lower Kuskokwim River (Commercial Fishing District 1), Alaska.

Year	Species	Number harvested	
		Subsistence	Commercial
1984[a]	Chinook	45,591	29,946
	Chum	84,834	396,031
1985[b]	Chinook	32,928	36,159
	Chum	57,974	191,208
1986[b]	Chinook	42,883	18,510
	Chum	95,835	304,201

[a] Alaska Department of Fish and Game 1985
[b] Alaska Department of Fish and Game 1987

Excessive turbidity—Refuge staff were concerned that excessive turbidity in the lower Kisaralik River may be caused by a point source erosion problem on Quicksilver Creek. Secchi disk measurements at the confluence of the Kisaralik River and Quicksilver Creek showed that light penetration in both rivers was similar. Visual observations revealed that the two streams were different colors (Kisaralik-blue-green; Quicksilver-brown), and that below the confluence, the river took on the color of Quicksilver Creek without a decrease in Secchi disk reading, producing the misconception that turbidity had increased.

However, an increased sediment load was found to affect light penetration in Section IV between rkm 50-60. Several high banks were being undercut by the action of the river forming 1-10 m overhanging banks. Bank erosion and collapse of these overhanging banks increased the sediment load and turbidity of the river. Secchi disk measurements decreased from 1-3 m to less than 5 cm within a 15 km reach.

Potential overharvest of rainbow trout—Rainbow trout were not as abundant in the Kisaralik River as other popular sportfish species such as Arctic grayling and Dolly Varden. Only 14 adults were captured and no fry or juveniles were collected. Except for lake trout, sport anglers caught rainbow trout less frequently than Dolly Varden and Arctic grayling in 1986 (Table 10). A large percentage of anglers came to the Kisaralik River to fish specifically for rainbow trout and indicated that their catches were low compared to their expectations.

Although additional data are necessary to more precisely assess the abundance of rainbow trout in the Kisaralik River, it is evident that population levels are not very high. Low rainbow trout populations in this system should not be unexpected, because the Kuskokwim River system

is the most northerly and westerly drainage in the North American distribution of naturally reproducing rainbow trout. The range of a fish species is usually limited by physical (mountain ranges, oceans) or environmental factors. Since the Kisaralik River is close to the northern edge of their range and environmental conditions in the area are extreme (cold water temperatures, short growing seasons, lower stream productivity), large populations would not be expected. Rainbow trout in the Kisaralik River are probably non-consecutive year spawners. Rainbow trout were not sacrificed in this survey to confirm this, but Alt (1978) found approximately one-third of the mature rainbows he collected to be nonconsecutive spawners.

Physical habitat does not appear to limit rainbow trout populations in the Kisaralik River. Spawning habitat in sections III and IV and overwintering habitat in sections IV and V appear to be adequate. However, no attempts were made to quantify habitat availability. Also, extreme discharge fluctuations could adversely affect rainbow trout populations. High flows could scour redds, dislodge eggs, decrease available rearing habitat, and flush fry downstream while low flows could expose spawning beds and strand juveniles in overflow pools. The river experiences large fluctuations in discharge. Data from the U.S. Geological Survey gauging station (Figure 2) located above Upper Falls (rkm 139) indicated a 24-fold increase in discharge between minimum and maximum flows for the 1986 water year (U.S. Geological Survey 1986). The 1986 water year was 14% higher than the seven year average from 1980 to 1986. Major water fluctuations took place shortly after rainbow trout spawned and again during chinook and chum salmon spawning. Flooding frequently made new channels through stands of willows, shifted gravel bars, and cut off and dewatered old channels.

Juvenile fish require low water velocity for rearing. Without adequate rearing areas, salmonid fry emerging from the gravel are unable to rest and are swept downstream. Ideally, a sequencing of riffles and pools assures sufficient areas of various habitat types. Few areas of quiet water were observed during high discharge periods. The area above Upper Falls was one continuous riffle and, in Section II, large boulders provided the only protection from currents. In sections III and IV, nursery areas had swift moving water and no replacement nursery areas were observed.

RECOMMENDATIONS

Depressed Salmon Populations

Observations during this survey and the Department's aerial index surveys suggest that Kisaralik River chinook and chum salmon populations are depressed. Kuskokwim River tributary spawning salmon stocks are affected by harvest in the mainstem river and cannot maintain a significant population unless there is adequate escapement into the tributaries.

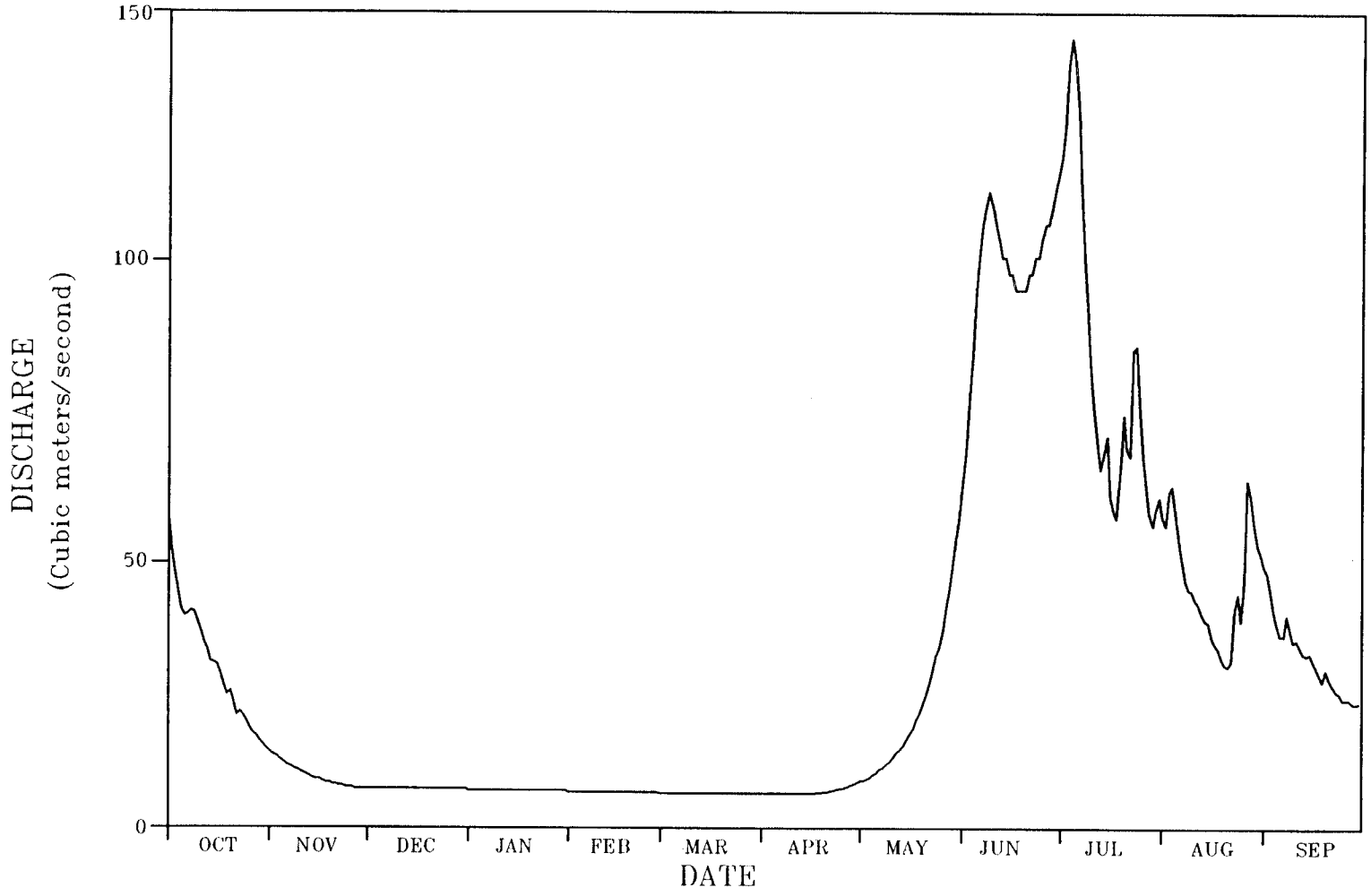

FIGURE 2. —Kisaralik River discharge at the U.S. Geological Survey gauge station, river kilometer 139, water year 1986, Yukon Delta National Wildlife Refuge, Alaska.

Because there is a lack of information concerning the abundance and run timing of the individual stocks as they pass through the mainstem Kuskokwim River, managing commercial and subsistence fisheries to minimize harvests of these depressed stocks is not possible at this time. An intensive multi-year study would be required to determine the abundance and run timing of the various salmon stocks within the Kuskokwim River drainage. Side scanning sonar may be capable of enumerating salmon and defining run timing.

No action should be taken at this time to provide migration structures at Upper Falls. Upper Falls should be evaluated during a low water year to determine if it is a barrier to migrating salmon.

Potential Overharvest of Rainbow Trout

Environmental conditions in the Kisaralik River are not apt to change in the future and the rainbow trout population is not likely to increase. Therefore, to maintain a healthy wild population, efforts must be taken to avoid overharvest. The reduced bag limit of two rainbow trout per day initiated in 1986 and modified in 1990 to allow only one over 508 mm in length should be maintained.

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